Advanced Simulation Framework for Design and Analysis of Space Propulsion Systems, Phase II

Completed Technology Project (2010 - 2012)

Project Introduction

The innovation proposed here is a high-performance, high-fidelity framework in the computational fluid dynamics (CFD) code called Loci-STREAM to enable accurate, fast and robust simulations of unsteady multiphase flows such as combustion involving liquid-gas phases in liquid rocket injectors and solid-gas phases in solid rocket motors, and cryogenic cavitation in delivery systems of liquid rocket engines. This framework will provide a state-of-the-art multiphase unsteady turbulent flow simulation capability employing Hybrid RANS-LES (HRLES) methods which are a blend of Reynolds Averaged Navier-Stokes (RANS) and Large Eddy Simulation (LES) approaches. Robust primary atomization models for liquid jet breakup and both phenomenological and stochastic secondary droplet breakup models will be developed. Lagrangian particle tracking and Eulerian multiphase models will be coupled to enable simulation of multiphase combustion involving solid particles or liquid droplets. The work proposed here will result in a state-of-the-art design and analysis tool to enable the accurate modeling of: (a) multiphase combustion in solid and liquid rocket engines, (b) combustion stability analysis (c) acoustic fields of space propulsion systems in near-ground operation, (d) small valves and turbopumps, etc. which constitute critical components of versatile space propulsion engines part of NASA's space near- and long-term space programs.

Primary U.S. Work Locations and Key Partners
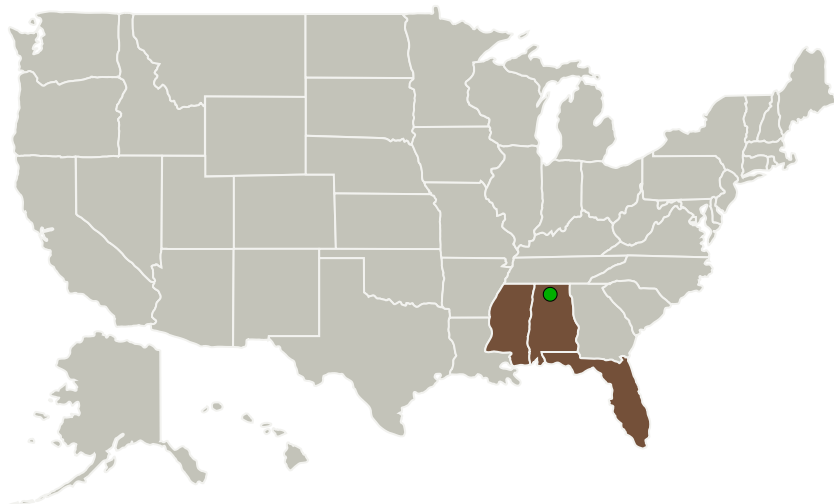
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Organizations Performing Work	Role	Type	Location
Streamline Numerics, Inc.	Lead Organization	Industry	Gainesville, Florida
🟢 Marshall Space Flight Center(MSFC)	Supporting Organization	NASA Center	Huntsville, Alabama

Primary U.S. Work Locations	
Alabama	Florida
Mississippi	

Project Transitions

▶ **August 2010:** Project Start

✔ **August 2012:** Closed out

Closeout Documentation:
- Final Summary Chart(*https://techport.nasa.gov/file/138799*)

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

Streamline Numerics, Inc.

Responsible Program:

Small Business Innovation Research/Small Business Tech Transfer

Project Management
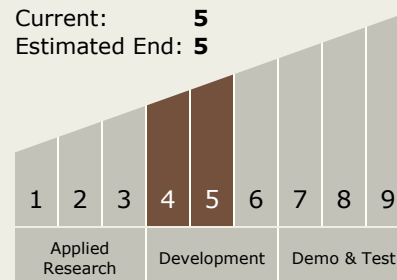
Program Director:

Jason L Kessler

Program Manager:

Carlos Torrez

Principal Investigator:

Siddharth S Thakur

Technology Maturity (TRL)

Start: **4**
Current: **5**
Estimated End: **5**

1	2	3	4	5	6	7	8	9
Applied Research			Development			Demo & Test		

Technology Areas

Primary:

- TX09 Entry, Descent, and Landing
  - └ TX09.4 Vehicle Systems
    - └ TX09.4.5 Modeling and Simulation for EDL

Target Destinations

The Sun, Earth, The Moon, Mars, Others Inside the Solar System, Outside the Solar System